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FUNDAMENTAL UNITS IN BIOLOGY[1]

By Professor H. S. JENNINGS

THE JOHNS HOPKINS UNIVERSITY

BIOLOGY has long sought to follow the example of physics by finding fundamental units, through the properties and combinations of which the phenomena of biology are produced, as the phenomena of physics are produced through the properties and combinations of its fundamental units. The history of biology yields long lists of the names and properties attributed to these supposed units. But till the recent rise of biological genetics, all these units remained hypothetical. Their existence and their properties were assumed, in order to explain the phenomena observed; they themselves were not observed.

But with the investigations of genetics in the last three decades, materials that have been claimed as the fundamental units of biology, and that at least in part fill the rôle of such, have emerged into the class of things that are observational. They are seen, at least as groups, under the microscope. Their location in the organism has been precisely determined, their arrangement and order discovered. Their properties and behavior have been to a great extent concretely investigated, their rôle in the life of organisms in large measure brought to light, though their physico-chemical nature remains as yet uncertain.

These are the materials known to biological science as *genes.* They yield in interest perhaps to no other units known to science, since a group of these develops into a living organism; into a human being, with all its powers; its consciousness and its intelligence.

Though these materials fulfil the conception of fundamental units as nearly as anything that is likely to be found in biology, they differ in many and important ways from the hypothetical units earlier postulated. The application to them of the phrase "fundamental units," with its connotation of fixity and simplicity and uniformity, brings with it the possibility of serious misconception. I should like to present a picture of their concrete properties and behavior such as may dispel these misconceptions. Whether, in view of the picture that emerges, it is to be held that biology has

[1] Address at the Mark Hopkins Centenary, Williams College, October 10, 1936.

indeed discovered fundamental units, I shall not undertake to decide. I shall first try to present the picture that arises through the study of genes in genetics and cytology. I shall at the end touch upon certain attempts to interpret them in terms of known physico-chemical phenomena.

Genes, as every one knows, are found within the nuclei of cells. They are grouped in coordinated systems which constitute the well-known structures called chromosomes. Single separate genes are not observed or known; seemingly the single gene can not exist by itself; certainly it can not long persist. But the chromosomes are known to be differentiated into separable parts—parts that can be disjoined and recombined into new groupings. It is in this possibility of separation and recombination that they show their unitary character. In view of this separability and varied power of recombination, taken in connection with the picture presented under the microscope, the genes are not uncommonly conceived as essentially separate particles, secondarily united into chains that form the chromosomes. The correctness of this conception is perhaps becoming questionable. I shall, however, present the known properties and relations of the genes in terms of this prevailing conception, later bringing out the possible necessity of a reinterpretation.

Looking upon the genes as separable units, it is certain that the number of genes in the single cell is very large. In a higher animal it is certainly not less than a thousand, and careful estimates of the number have run as high as fourteen thousand. The entire group of genes is present in the nucleus of the single cell with which every individual begins life. As the cell divides, producing the many cells of the body, every gene divides, its products passing to all the cells. Thus every cell of the developed body contains the entire set of many genes, though to this there are some exceptions. The development of the individual is brought about through the interaction of these many genes; the nature and characteristics of the individual that is produced depends on the particular combination of genes that is present in the original cell, as well as upon the conditions to which they are subjected.

The genes are known to be arranged serially within the nucleus, as are beads on a string. The string of genes is seen under the microscope as the thread-like chromosome. At certain periods such a thread is seen to bear at intervals minute particles forming a series. These particles, known to the cytologist as chromomeres, have the positions and arrangement which on other and quite independent grounds the genes are known to have. It has seemed possible that they are indeed the genes; or that at least they contain the single genes.

The genes are not a series of identical particles. On the contrary, each gene differs from every other gene in the series. Thus a thousand or more diverse types of genes exists in the single cell. It is by the complex interaction of these many different agents that development is brought about and the organism produced. The single gene, not by itself capable of development, supplies to the great complex of physiological processes some necessary ingredient or agent, without which development can not occur. Thus the single cell that is ready to develop may be compared in constitution to an enormously complex formula from which is to be produced some organic product. If each ingredient in such a formula is conceived to be concentrated in a minute particle, and all the diverse particles are strung in serial order on a filament, the resulting structure seems comparable to the system of genes in the cell nucleus.

The system thus formed is uniform and orderly. Each different type of material, each gene, has its precise place in the system, so that different gene types can be located, their serial numbers given. Many of them have been named. Detailed maps of the relative positions of many of the different genes in the system have been made for certain organisms.

With very rare exceptions, each one of the great number of genes present in the system is necessary to the life and development of the organism. If the elaborate system is made imperfect by the loss of any single one of the many known gene types, the organism does not develop; it can not live. To this, exceptions are very rare.

Thus the gene is not a unit in the sense that it can live and develop by itself. On the contrary, it depends for its life and functioning on the presence and cooperative action of a great system that includes hundreds or thousands of gene types with different properties. It is in the fact that they can be separated and recombined that the genes behave as units. But as we shall try to indicate later, it is possible that they are not properly to be considered self-contained units, but only as coordinated parts of complex structures acting as organic wholes.

Different organisms have diverse sets of genes, the different genes of the set having different properties and behavior from those of other species. Thus the number of diverse types of genes that occur in the organic world is practically infinitely great. Within the same species the different individuals have many genes in common; that is, they have genes of the same descent, and of the same properties and behavior. But such individuals of the same species usually differ in some of their genes, few or many. Two such individuals may have gene systems that are identical in

properties in all their genes except a single one; or they may differ in two or in any number.

The individuals thus differing with respect to certain genes show correspondingly different characteristics, structural or physiological. A blue-eyed individual may differ from a black-eyed one in but a single gene. There are many diversities between individuals that thus result from a difference in single genes.

But for every gene in one of the differing individuals of the species, there is a corresponding gene in the other individual; a gene corresponding in location within the chromosome system, and in properties. Making allowance for sex differences, every individual of the species has the same number of genes, arranged in the chromosomes in the same order, the genes that occupy corresponding positions having identical or similar properties and functions.

But two genes occupying corresponding positions in the two individuals, although they have similar properties, similar functions, may differ to some extent in their properties; differ somewhat in the way they perform their common function. One may produce blue eyes, another brown eyes, a third gray eyes. One may tend to produce a strong individual, another a weak one. The number and degree of such diversities in the action of corresponding genes is very great, among the many individuals of the species taken as a whole.

Thus there are two types of diversities among the genes of a given species, such as man:

(1) In the single individual the many different genes in the long series differ in their physiological action, in their functions, in the effects that they produce in development. One gene has its primary function in producing the color of the eye, another in determining the physiological properties of the blood; a third affects primarily the rate of growth; and so on for the hundreds or thousands of different genes. The entire group must work in coordination, if the individual is to live and develop. We must thus distinguish a great number of diverse genes in the same individual.

(2) In different individuals of the same species, as we have seen, the genes at corresponding locations, although they have the same general functions, may differ in the way they perform these functions; they differ to some degree in their properties. Some examples of the given gene may be weak or imperfect, others may be strong and perfect. One may produce blue eyes, another black eyes. One may give rise to a certain blood type, another to another blood type. These corresponding genes, differing in different individuals, are known as alleles or allelomorphs; they are derived by modification from a single gene type. Thus a given gene type, occupying a certain definite position in the chromosome, may have many diverse modifications or alleles, present in different individuals. This adds greatly to the number of diverse gene types present in the species.

The grouping of the genes into chromosomes differs greatly in different species. In the individuals of the same species or variety the grouping into chromosomes is as a rule the same. Yet in some cases there are diversities in the order of the genes in the chromosomes, among individuals of the same species. Such diversities in the order of the genes commonly make but little difference in the characteristics of the organism. Yet if the order of the genes is artificially altered, as may be done by the use of radiations, in many cases development and characteristics *are* altered; they are usually made in some respects abnormal. The ground for this change of characteristics with change of relative position of the genes is not yet clear. It may be the result of injury to the genes brought about at the time their relative positions are altered; or possibly the relative position has itself some effect on the functioning of the genes. This is a matter that is now under active investigation. If the gene system is artificially broken up, so that it no longer contains the full ordered set, development and life cease.

A further feature of the system of genes is of great practical importance. In some of the lower organisms the genes within the cell form a single chain or linear system, each gene in the chain differing from every other. But in all higher organisms, two cells unite at the beginning of individual life to form a single cell. The cells so formed—the fertilized egg cells—have double chains of genes, one chain derived from each of the two cells that have united. Each of the two chains contains the full set of genes, so that all the different gene types are in pairs. This is the state of the case in the cells of all the higher plants and animals and in many of the lower ones.

The two systems present in the same cell, but derived from different parents, may differ in the properties of some of their corresponding genes; that is, they carry different alleles of certain genes. One member of a certain pair of genes may thus tend to produce an effect somewhat different from that produced by the other member. One of the two may be weak or defective; in that case the remaining normal gene performs the function for both. The doubleness of the genes thus acts as an insurance factor; if one gene of the pair does not play the proper rôle, the other gene takes over that rôle. The doubleness of the gene system is what gives rise to the most characteristic and perplexing features of heredity; it is the basis of the numerical proportions seen in the Mendelian rules or laws.

Our knowledge of the diversities among genes and of their functions in determining the characteristics of

organisms comes from the fact that at reproduction new combinations of genes are formed. The single parent cell, containing two complete sets of genes, divides into germ cells, each of which contains but one complete set of genes. Now, in preparation for this division into germ cells, the two sets of genes in the parent cell unite in pairs, the two corresponding genes forming the united pairs. After this union the two again separate, and in so doing there is often an exchange of some of the genes between the two systems. Now when the division into germ cells occurs there are produced in the different germ cells combinations of genes differing from the combinations that existed in the parents. By the union of such germ cells at fertilization, many diverse combinations of genes are produced. By study of the individuals that develop from these germ cells, the effects of altering the gene combinations can be discovered. This is the method by which all our knowledge of these things has been obtained.

Such analyses of the results of changing the gene combinations have been carried far; they constitute the experimental study of Mendelian inheritance. An elaborate technique has been devised—each step of which requires a generation of the organism studied. This technique is a powerful instrument. By its aid the results of changing any one of the known genes are determined; or the results of changing two, or many. It is to this that our detailed knowledge of the properties and effects of the different genes is due.

Thus the genes combined into particular systems may be separated and recombined into new systems; thus the single gene may be removed from one combination and transferred to another. It is in this respect that the genes act as units. But the gene, when removed from one system, must, in order to produce development, find its proper place in another complete system. In the development of the organism and the production of its characteristics the genes do not act as units, but as coordinated materials interacting to produce a harmonious result.

Moreover, the single gene does not represent or produce any single part or characteristic of the organism. The single gene does indeed, in many or most cases, have its most conspicuous effect on a certain feature of the organism, as the eye or the blood. But the single gene is known to affect also many other features; and to have a constitutional effect on the organism as a whole. Further, it is known that every feature of the organism is affected by many different genes. Any part or characteristic is built up by the coordinated action of many genes. The genes must be conceived to produce organic materials which interact in a long series of reactions that ultimately produce the developed organism.

The genes affect development and characteristics through interaction with the cytoplasm in which they are imbedded, this cytoplasm constituting the remainder of the cells. Cytoplasm is absorbed into the nucleus; here it comes under the direct action of the genes and is modified by them. It is given off from the nucleus in modified condition. In the single cell different portions of the cytoplasm become thus differently modified. By division of the cells, some receive cytoplasm of one type, others of another type. By continuation of this process, the details of which are yet obscure, the different types of cells and of tissues are produced. Each different type of cell seemingly still contains the entire set of genes. Thus the different types of cells within the single organism differ in their cytoplasm, not in their genes. The differentiations of the body therefore have their seat in the cytoplasm, but they are produced under the action of the genes, and are diverse with different genes.

Thus the cytoplasm plays a great and essential rôle in development and the production of characteristics. This being so, the question is asked: Is there ground for considering the cytoplasm less fundamental than the genes? And is the conception of *units* applicable to the cytoplasm? Is it not misleading to designate the genes as the fundamental units of biology, in view of the existence and functioning of the cytoplasm?

There is some ground for the criticism implied in these questions. The cytoplasm is as essential to life and development as are the genes; and this means a limitation of the conception that the phenomena of biology are the result of the properties and combinations of the genes as fundamental units. The important thing is that the rôle of genes and of cytoplasm is different in kind. So far as experimentation shows, the seat of diversity among different individuals is almost exclusively in the genes. The diversities of inherited characteristics are due to diversities among the genes. Only in rare instances and in slight degree are there known cases in which diversities of cytoplasm cause diversities among the individuals of a species, and thus affect heredity. Diversity of sex, diversity of structure, diversities in fundamental physiology—all these are abundantly produced by diversities among genes, hardly at all by diversities in cytoplasm. It is by changes in the genes through radiation or the like that inherited changes in characteristics are produced. In the relatively few cases in which diversity of characteristics results from diversity of cytoplasm, there are indications that the diversity of cytoplasm is originally due to diversity of genes, and is brought about by the action of different genes on the cytoplasm. The general picture leaves the impression that evolutionary changes in organisms are in the main or exclusively the consequences of alterations in the genes, not

of alterations in the cytoplasm. On the whole the cytoplasm appears to play a uniform and relatively passive rôle, as compared with the varied and active rôle of the genes. Even in the development of the individual, the genes appear to initiate and determine the nature of the differentiations that appear in the cytoplasm.

The action of the genes in development is not stereotyped and invariable. On the contrary, the genes are elaborately sensitive and responsive to the conditions which surround them; they change their action and effects in accordance with the conditions. Every cell of the developing body contains the same set of genes. Yet this same set produces in diverse parts of the body totally different structures and functions. Some of the cells produce nerve tissue, others muscle, others bone, others connective tissue, others mucous or serous membrane. Some produce eyes, others wings, limbs, integument, brain, alimentary canal—all operating with the same set of genes. How in detail the genes so react or are so controlled as to give with the same set the many diverse parts and functions of the organism is as yet one of the darkest problems of biology. Some slight beginnings of knowledge of these matters have come through experimental embryology. By altering the conditions in certain parts of the developing organism, the gene system here may be induced to produce parts that normally it would not have produced. The single cell, with its gene system, appears capable of producing any part or function of the body, depending on the conditions to which it is subjected.

Turn now to certain other properties of genes. In reacting with the cytoplasm and with the conditions of the environment, the genes are not used up. Always a reserve portion of each gene remains and perpetuates the gene type by division. Each of the many different types of genes reproduces true to type. Each gene assimilates nutritive material, producing thus more of its own kind of substance. Then this material divides, and by a continuation of the process many genes of this type are produced, scattered through all the cells of the body. This distinctive assimilation and reproduction of its own kind of material by each type of gene is the fundamental phenomenon of heredity. The distinctive gene type is maintained, even though the conditions to which the gene has been subjected may have altered greatly its activities and products. The gene shows a high degree of resistance to change in its fundamental nature. This is the ground for the usual lack of inheritance of acquired characters.

But paradoxically, one of the most remarkable and important properties of the gene is that it may become altered, modified; and that it may assimilate and reproduce in this altered state, giving rise to additional genes of the altered type. On this fundamental property of genes rests the process of organic evolution. By transformation of the genes, the organisms they produce are transformed. By reproduction of the genes in their transformed condition, the transformed organisms are perpetuated, later forming the foundation for further transformations.

Until recently nothing was known as to the effective agents inducing such transmissible changes in genes. At the present time certain agents are known that bring about such changes; but our knowledge is negligible when confronted with the changes shown in organic evolution. Certain radiations may alter the genes without killing them. But these altered genes bring about injuries and weakness in the individual that carries them. The weakened and injured genes assimilate and reproduce in their damaged condition, giving rise to organisms that are weakened, deformed or abnormal; and this inheritance of the defective condition continues for generations or indefinitely. Similarly weakened or damaged genes are producible by subjecting the developing organism to abnormally high temperatures. Whether radiations and high temperatures may ever cause inherited gene modifications that increase vitality or are beneficial to the organism is a question on which the evidence is not yet clear. Certainly the overwhelming majority of the gene changes so induced are harmful; it may be doubted whether any such changes not harmful have been produced.

But in organic evolution, transmissible gene changes that increase the fitness of the organism for life and development have certainly occurred on a grand scale. We know as yet little or nothing as to how these changes are produced.

Our account thus far has presented the main features of the genes so far as they have been discovered through investigations in genetics and development. Such investigations are the main sources of knowledge of genes. But through them the genes are known mainly, though not exclusively, in an indirect way, through the effects which they produce. Our presentation has dealt mainly with such effects, and with conditions that are postulated as necessary for the production of such effects.

Can we approach the genes more closely and directly, forming an idea of what they are as material bodies in space; as they would be described in chemistry or physics? Such knowledge of the genes is as yet largely hypothetical. We may, I believe, expect great changes in this matter: changes that may revolutionize our interpretations; they may come soon.

Some investigators of the genes believe that they must be considered single molecules of a complex character. Others hold, on the basis of size relations, that the single gene probably consists of a number of

molecules. It is sometimes suggested that one such gene, whether unimolecular or multimolecular, is lodged in each of the chromomeres which at certain stages are visible in the chromosomes. Naturally, though not necessarily, going with these ideas, is the conception that the genes are primary as compared with the chromosome; that the chromosome is a secondary aggregation of genes, which conceivably might be separate.

Another conception of the matter has been presented and has come into some prominence of late. It is a conception which would change in some fundamental respects the interpretation of the phenomena that I have described, though the phenomena themselves would of course remain. According to this conception, the chromosomes are the primary and unitary structures, while the genes are but differentiations in the length of the filamentous chromosomes. This idea has recently been ably worked out, from the standpoint of physical and organic chemistry, by Dr. Dorothy M. Wrinch.[2] According to this view, the chromosome is to be conceived as a structure constituted of two types of elements making a sort of warp and woof. The warp is a set of longitudinal filaments or bundles composed of "identical sequences of protein molecules in parallel"; the woof of a set of ring-like nucleic acid molecules surrounding the protein filaments and holding them together. The longitudinal protein bundles are held to consist of "polypeptide molecules placed end to end with suitable linkages." These molecules thus placed end to end are not identical, but are held to differ in a definite pattern, so as to form a linked chain of diverse molecules, indicated by Wrinch in the following formula:

$$A_1\,B_1\,C_1 \ldots X_1\,Y_1\,Z_1,\ A_2\,B_2\,C_2 \ldots X_2\,Y_2\,Z_2,\ A_n\,B_n\,C_n \ldots X_n\,Y_n\,Z_n$$

These molecular diversities constitute the basis for the differentiations that give rise to the conception of genes. The nucleic acid rings form transverse darkly staining bands, distributed at irregular intervals along the length of the chromosome, their location and extent depending on whether the reaction of the protein molecules beneath them is prevailingly acid or basic.

Recently certain huge chromosomes—the salivary chromosomes of insects—have been minutely investigated. These show a banded structure such as agrees with the conception of Wrinch; and it has been proved that these bands have definite and constant relations to known genes. So far as they go they perhaps support the conception of the chromosome that I have just described.

According to this view of the matter, then, it is the chromosomes that are primary, the genes being but differentiated regions in them, which may be broken apart and recombined with the corresponding part of similar block taken from it at any other level. Any such block might be called a gene. This conception, if it finally prevails, will considerably alter the picture of the genes and their relations, and may serve as a guide to fruitful study of their properties and mode of operation. It would possibly incline us to answer in the negative the question whether biology has discovered fundamental units comparable to those of physics. But it will not materially alter the general picture of the relation of genes to development and heredity, as I have just tried to present it. Whether the genes are essentially separate units or only differentiations in the body of the chromosomes, they are structures which, when in appropriate combinations, give rise to living, conscious organisms; and which, by the changes that occur in them, give origin to the infinite variety of the organic world, and to the changes that we call organic evolution.

OBITUARY

WILLIAM BUCHANAN WHERRY[1]

1875–1936

BORN of missionaries in India, in 1875, raised in our Middle West, wanderer into the Philippines, Japan and Hawaii and dead in Cincinnati in the night of November first, 1936—such is the material sequence in the life of William Buchanan Wherry. Accompanying it, like a shadow, is the story of a soul.

The spirit spoke Hindoostani before it could lisp English—and never forgot that tongue. And forever after was it thus to speak more of the mystery of life and less of life's obviousnesses.

At fourteen he was catapulted into the rough surroundings of Chicago's offside; at seventeen made a student of the classics in conformist Pennsylvania, to learn there, non-conformity.

Then back—because more convenient—to the Middle West, where he was to walk with gods, sunk like himself in the mire of man's life on Halsted Street—Ludvig Hektoen, Frank Billings, Edwin Oakes Jordan. Whereafter he lived for a season with Theobald Smith. Now blessed with the hallowed oil of their approval, he entered the fight on his own, out where the frontiersman struggles 'gainst miasma, 'gainst pestilence and

[2] Dorothy M. Wrinch, *Protoplasma*, 25: pp. 550–569, 1936.

[1] Tribute read into the service at the funeral on the morning of November third in the auditorium of the Medical School of the University of Cincinnati.

creeping death. Thus for three years did he labor in Manila where fever ran high, where suffering was great and men spat blood, black.

Veteran, he returned to America, sans fat, sans medals, sans the frogs even on a military officer's coat, to apologize that so lowly of the Lord could not set fish before his friends.

Without a job, then with a job, with money, even, he bought a diamond as tribute to the girl who for thirty years was to bring him peace, comfort and the quiet of restful background. That was home.

But his life and work lay—as they had always—outside. And so forward once more to lovely California to risk death 'midst rats, 'midst fleas and bubosed men. The end? The finding that on the West Coast plague stalks in the ochred hills and in the pretty yellow skins of ground squirrels.

In 1909 medical Cincinnati felt the need of repair. Its spirit was drooping and blood was needed. Who better than this youngster of many countries and many views? And for twenty-seven years he furnished just this.

Here he labored, and delightedly. So it was that he made large contribution to that play which had always intrigued him—the battle of all living things against environment and the battle of each against the other. Here he became world master in a field, and of those few who see not fact but philosophy.

In 1913 he recognized an eye infection in a patient as identical with a disease of California's ground squirrels; and tularemia in man was born. Unknown, it had long been the nemesis of the rabbit hunter and the butcher, to whom, after infection, life was a despairing gamble. But it was less so, by much, when Wherry finished with a serum.

The development of a resistance-bearing serum in this instance was, however, but one of a set of them. When yet a medical student he had pushed forward the vaccine studies of Pasteur and Wright and, in the free moments since, he had applied himself further to this task. Thus, by better winging of the offenders, did he lift the odds in staphylococcus, streptococcus and typhoid infection.

In the 20's of this century the urge of the Orient came again upon him. Had he not written out of that dream state which appeared always to be his, in 1913: "Encircling the earth, between 30° N. and 30° S. are tropical and subtropical regions—the most beautiful, the most fertile, the most richly endowed portions of the globe. Time and again they have been invaded. . . . Stricken by strange pestilences, the invaders have disappeared . . . there lies 'the white man's grave.'"

And better to cheat it, for a season, he went where East touches West; then year after year, into Mexico, Hawaii, the Philippines or Japan to study their amœbae, their worms, their sprue, their leprosy. All life was his field and all life fell under the scrutiny of his piercing sight, to reveal itself, times without number, as to the confessor. Thus he learned how to grow the leprosy out of rats and later out of man.

Amid these labors and in the circle of those he loved best, his eyes closed to the everlasting sleep. So today he is no longer one of us, but one of the glorious company of God's chosen.

Because of his being, men know more and think differently. The voluntary adherent of no orthodoxy, life made him slave to her greatest—the truth itself. This he used to whisper to students sitting close, to colleagues, to those who were the intimates among the friends whose number was legion. Out of his smile the despairing drew hope; out of his mind, healing; from his somewhat frail body his associates tapped strength.

And so of this figure who in life walked so frequently before us into the darkness, we can but say that in death he has preceded us again. We do not cry: Farewell! We lift our arms to call: Hail!

MARTIN H. FISCHER

RECENT DEATHS AND MEMORIALS

DR. WILLIAMS MCKIM MARRIOTT, dean of the University of California Medical School, died on November 11 at the age of fifty-one years. He had been ill since receiving the appointment last August. Dr. Marriott was appointed professor of pediatrics at Washington University, St. Louis, in 1917. For thirteen years before going to California he was dean of the Washington University School of Medicine in St. Louis, having previously taught at the University of North Carolina, at Cornell University and at the Johns Hopkins University.

DR. AUGUSTUS HERMAN GILL, professor emeritus of chemistry at the Massachusetts Institute of Technology, a member of the Massachusetts State Board of Health, died on November 11 at the age of seventy-two years.

FRANK A. LAWS, professor of electrical measurements at the Massachusetts Institute of Technology until his retirement as professor emeritus in 1932, died on November 12 at the age of sixty-nine years.

DR. THEODORE BRENTANO WAGNER, chemical engineer of New York City, died on November 12 at the age of sixty-seven years.

DR. JOSEPH G. MAYO, son of Dr. Charles H. Mayo, of the Mayo Foundation, Rochester, Minn., was killed in an automobile accident on November 9. Dr. Mayo entered the Mayo Foundation as a fellow in July, 1928, and was made an associate in medicine in the Mayo Clinic in July, 1934.

DURING the session of the International Congress of Quaternary Geologists, held in Vienna, from September 1 to 9, a monument to the memory of the late Dr. Josef Bayer was unveiled at Spitz on the Danube. The spot selected for the monument is near the world-renowned prehistoric station of Willendorf, where the Paleolithic figurine known as the Venus of Willendorf was found.

SCIENTIFIC EVENTS

THE INDIAN JOURNAL "CURRENT SCIENCE"

A CORRESPONDENT writes from India as follows:

With the publication of the July number, our Indian contemporary, *Current Science*, has entered its fifth year. We have been in close touch with the foundation and progress of this journal and it should be a matter of satisfaction to all those interested in the progress of science in India, as it is to us, that this all-India journal, based on the model of the well-known British weekly, *Nature*, has proved such a success. Within four years, it has established itself as a necessity for men of science in India and has received encouraging recognition in western countries.

The great success which *Current Science* has achieved is not a little due to what may be considered a unique feature of the journal, namely, that its editor-in-chief, Professor C. R. Narayan Rao, is assisted by a large body of cooperators comprising the majority of the best-known scientists in the country, a feature which has invested the journal with a really all-India character and outlook.

It should be obvious to every one who has followed the fortunes of *Current Science* that the editor has invested the journal with a progressive policy, and year after year new features, calculated to enhance its sphere of usefulness and influences, are being introduced. The journal has maintained a high standard and thereby gained a prestige for authoritatively portraying to the world of international science the meritorious and important scientific investigations conducted in India. It has sought opportunities for establishing a link between science and government on the one hand and on the other, between science and society. The journal has secured the sympathetic collaboration of a distinguished body of foreign scientists and its scope and function have already assumed an international character. More recently the editor has organized the publication of a series of special numbers dealing with specific subjects, the various aspects of which have been treated by the foremost authorities; four of them dealing with ''Canal Rays,'' ''Laue Diagrams,'' ''Genetics'' and ''Organizers in Animal Development,'' are to be issued in the near future. Special supplements dealing with outstanding scientific topics have already become a feature of the journal. Measures are now being taken to broaden the scope of the journal by the publication of contributions appealing more directly also to the cultivated reader so that he may be brought into sympathy with the progress of science, not only in this country but throughout the world. These and other desirable improvements contemplated will undoubtedly enable *Current Science* to establish for itself a name not unworthy of India.

THE JOURNAL "GROWTH"

ANNOUNCEMENT has been made of the publication of a new journal entitled *Growth*, "for studies of the basic factors, processes, and functions concerned in growth as a fundamental property of nature; whether these be expressed in plants, animals, crystals, or populations." The journal will be published by contributors and subscribers as "a non-profit cooperative medium for the integration of growth expressions through the basic sciences."

The journal is conducted by an editorial board of eighteen members, the council of which consists of five members. These are: S. Brody, University of Missouri, nutrition; H. L. Dunn, U. S. Bureau of the Census, mathematics, demography; P. W. Gregory, University of California, Davis, genetics; O. Rahn, Cornell University, microorganisms, bacteria, yeasts; H. S. Reed, University of California, plant growth. Other members of the board are: N. J. Berrill, McGill University, organization; S. A. Courtis, University of Michigan, intelligence and learning; Chas. B. Davenport, Cold Spring Harbor, New York, child growth; L. K. Frank, New York City, philosophy; W. R. Graham, University of Missouri, nutrition, vitamines; Leigh Hoadley, Harvard University, differentiation; Leo Loeb, Washington University, hormones; D. M. Pace, the Johns Hopkins University, microorganisms, protozoa; S. P. Reimann, Lankenau Hospital Research Institute, Philadelphia, pathological growth; R. Scammon, University of Minnesota, human growth, embryology; T. Wingate Todd, Western Reserve University, anthropology, history; P. R. White, Rockefeller Institute, Princeton, proliferation; F. S. Hammett, chairman of the board, Lankenau Research Institute, Provincetown, Mass., chemical-physical factors.

To aid in covering the expenses of the journal each author will be expected to send with his paper an order for 100 reprints, at a cost of $3.75 a page. Tables, charts and the like will be charged according to size and method of reproduction desired by the author. The papers will be issued at irregular intervals, the first of which it is expected will appear in January next. Subsequently the numbers for a year will be collected in a volume.

RESEARCH ON OPTICAL GLASS AT MELLON INSTITUTE

A broad program of fundamental investigations on the chemistry and physics of glass surfaces to aid in the development of scientific apparatus and ophthalmic instruments has been started at Mellon Institute of Industrial Research by the Bausch and Lomb Optical Company, of Rochester, N. Y. The first studies will be concerned with the effects of environmental factors on the durability of the various types of glass used in optical instruments.

The Bausch and Lomb Optical Company, whose research in optical glass dates from the initial work of William Bausch in 1912, has maintained a fellowship at Mellon Institute since 1931 for research on various plant and production problems in optical technology. New developments in the past have included improved greases for optical instruments, cements for ultraviolet transmitting optics, improved methods for making and testing mirrors and reflectors, and standardization of the sizes of fine abrasives used in grinding lenses.

Dr. Frank L. Jones, the fellow since 1930, will be in charge of the new investigations of the Bausch and Lomb Optical Company at Mellon Institute. An enlarged staff will continue the work on plant problems at the new research laboratory of the company in Rochester. Dr. Jones received his professional education at Bucknell (B.S., 1925) and at Columbia (A.M., 1927; Ph.D., 1931).

FIFTH INTERNATIONAL CONGRESS FOR APPLIED MECHANICS (1938)

The American committee, to whom has been delegated responsibility for organizing the fifth International Congress for Applied Mechanics by the International Committee at its meeting at the University of Cambridge, England, in July, 1934, announces that the fifth congress will meet in Cambridge, Mass., from September 12 to 16, 1938, at Harvard University and the Massachusetts Institute of Technology. As in the past, this congress is to be a meeting of those working in the field of applied mechanics before whom reports of recent work may be presented for discussion.

The program will cover three main divisions of applied mechanics as follows:

1. Structures, Elasticity, Plasticity, Fatigue, Strength Theory, Crystal Structure.
2. Hydro and Aerodynamics, Gasdynamics, Hydraulics, Meteorology, Water Waves, Heat Transfer.
3. Dynamics of Solids, Vibration and Sound, Friction and Lubrication, Wear and Seizure.

Following the meeting at Cambridge, it is expected that arrangements will be made to visit the National Bureau of Standards, Washington, and the National Advisory Committee for Aeronautics at Langley Field.

Dormitory and boarding facilities will be made available by Harvard University. Inquiries should be addressed to the Fifth International Congress for Applied Mechanics, Massachusetts Institute of Technology, Cambridge, Mass., U. S. A.

Th. von Kármán
J. C. Hunsaker
Secretaries

AUTUMN GENERAL MEETING OF THE AMERICAN PHILOSOPHICAL SOCIETY

The American Philosophical Society Held at Philadelphia for Promoting Useful Knowledge will hold the first of the autumn general meetings on November 27 and 28. The sessions for the reading of scientific papers are open to the public. The program is as follows:

Friday Morning, November 27, at 9:30 o'clock
Edwin G. Conklin
Vice-president, in the Chair

Land Mollusks from Cozumel Island, Mexico, and Their Bearing on the Paleogeography of the Region: Horace G. Richards, research associate, New Jersey State Museum.

Exploration in Northern Mexico for Mollusks in 1934–35: Henry A. Pilsbry, The Academy of Natural Sciences of Philadelphia.

Studies of Morphological Variations in the Intestinal Amoebae of Man with Special Reference to the Nucleus: David H. Wenrich, professor of zoology, University of Pennsylvania.

Somatic Segregation in Relation to Atypical Growth: Donald F. Jones, Connecticut Agricultural Experiment Station.

Extra-chromosomal Influence on the Incidence of Tumors in Mice: Clarence C. Little, director, Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

Quantitative Studies of Radium Poisoning: Robley D. Evans, assistant professor of physics, Massachusetts Institute of Technology.

Color Changes in Fishes and the Autonomic Nervous System: George H. Parker, professor emeritus of zoology, Harvard University.

Effect of Hemorrhage and Peptone Injections on Platelet Production in the Lungs: William H. Howell, professor emeritus of physiology, the Johns Hopkins University.

The Structure and Function of the Facial and the Labial Pits of Snakes: G. Kingsley Noble, American Museum of Natural History.

The Rhinoceroses of the White River Oligocene: William B. Scott, professor emeritus of geology, Princeton University.

Evolution of the Elasmotheres. (To be read by title.) Horace Elmer Wood, 2d, professor of biology, University of Newark.

Luncheon for members and invited guests at 1 o'clock.

FRIDAY AFTERNOON AT 2 O'CLOCK
Henry H. Donaldson
Vice-president, in the Chair

An Archeological Discovery in the Guatemala Highlands: Alfred V. Kidder, Division of Historical Research, Carnegie Institution of Washington.

Cenozoic Cycles in Asia and Their Bearing on Human Prehistory: Hellmut De Terra, research associate, Carnegie Institution of Washington.

Report on Linguistic and Cultural Studies among the Todas and Other Dravidian Peoples, 1935–36. (To be read by Professor Franklin Edgerton.) Murray B. Emeneau, research assistant, Yale University.

Some Results of the Excavations at Olynthus: David M. Robinson, professor of archeology and epigraphy, lecturer in Greek literature, the Johns Hopkins University.

The Excavation of Bethel: William F. Albright, professor of Semitic languages, the Johns Hopkins University.

Results of a Search for Lost Greek Sculptures: William Bell Dinsmoor, professor of archeology, Columbia University.

The Union Catalogue of the Philadelphia Metropolitan Area: Conyers Read, professor of English history, University of Pennsylvania.

FRIDAY EVENING AT 8:15 O'CLOCK

D'Arcy W. Thompson, professor of natural history, St. Andrews University, Scotland, will speak on *Astronomy in the Classics.*

SATURDAY MORNING, NOVEMBER 28, AT 10 O'CLOCK
Roland S. Morris
President, in the Chair

The Theory of Some Chemical Reactions: Henry Eyring, assistant professor of chemistry, Princeton University.

The Chemical Concentration of the Carbon Isotope: Harold C. Urey, professor of chemistry, Columbia University.

Report on the Mass Analysis of the Chemical Elements: Arthur J. Dempster, professor of physics, University of Chicago.

The Design of Powerful Electromagnets: Francis Bitter, associate professor of physics of metals, Massachusetts Institute of Technology.

The Nature of Cosmic Rays: W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute.

Impulse Methods for Ion Acceleration: Jesse W. Beams, professor of physics, University of Virginia.

Radioactivity, Measurement of Time and Difficulties: Alfred C. Lane, professor emeritus of geology and mineralogy, Tufts College, Massachusetts.

The Verification of the Lunar Theory: Ernest W. Brown, professor emeritus of mathematics, Yale University, and W. J. Eckert.

Luncheon for members and invited guests.

THE MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE IN PHILADELPHIA

ON invitation of the American Philosophical Society, the Franklin Institute, the Academy of Natural Sciences, the University of Pennsylvania and other scientific and educational institutions, the American Association for the Advancement of Science and its associated societies will meet in Philadelphia on Saturday, January 2, following the adjournment at Atlantic City on the evening of Friday, January 1.

Some of the sections of the American Association for the Advancement of Science and some of the affiliated and associated societies have planned to end their sessions at the Atlantic City meeting on Thursday evening. This is unfortunate for several reasons; it causes a serious overcrowding of programs in the earlier days of the week and it withdraws support from the programs of the last two days. It has been a source of criticism for many years that the programs of convocation week are brutally overcrowded. Sessions of related subjects conflict in time and individual programs are so crowded that there is no time for discussion. Papers are run through the mill in the most approved "mass production" method and one wonders why any person should care to present the results of long and laborious scientific work in such a manner.

By contrast at the British Association the sessions generally last throughout the week and much time is given to the discussion of the papers which are offered. Teas, luncheons, dinners, receptions and excursions lend a most agreeable social aspect to their meetings. The American Association might well follow the practice of its prototype in these respects.

At the Atlantic City meeting it is expected that there will be important lectures and moving pictures of general scientific interest on Friday, January 1. On Saturday it is planned to hold a symposium at the American Philosophical Society in Philadelphia on some of the latest advances in the biological and medical sciences. Following the symposium there will be a complimentary luncheon for members of the association and affiliated societies in the Hall of the American Philosophical Society. This oldest scientific society in America has occupied its present building on Independence Square for more than 150 years, and it is well worthy of a visit by members of the American Association for the Advancement of Science. After luncheon transportation will be provided to other places of scientific interest in Philadelphia, and particularly to the Academy of Natural Sciences, the Franklin Institute and the University Museum. These institutions will keep open house for visitors on this occasion and it is hoped that a goodly number of those who have attended the Atlantic City meeting may take advantage of this opportunity to see some of the recent important advances in the scientific institutions of Philadelphia.

EDWIN G. CONKLIN,
President of the Association

SCIENTIFIC NOTES AND NEWS

The Nobel prize in physics for 1936 has been awarded jointly to Dr. Carl David Anderson, of the California Institute of Technology, and Dr. V. F. Hess, of the University of Innsbruck, discoverer of cosmic radiation in 1912; Dr. Anderson was twenty-seven years old when he discovered the positron, or positive electron, in 1932, while investigating cosmic rays.

The Nobel prize in chemistry for 1936 has been awarded to Dr. Peter Debye, of the University of Berlin. Dr. Debye, known for the Debye-Huckle theory in physical chemistry, gave an address at the Harvard Tercentenary celebration.

Dr. William E. Ritter, emeritus professor of zoology at the University of California, emeritus director of the Scripps Institution of Oceanography and honorary president of Science Service, celebrated his eightieth birthday on November 19.

Dr. George Henry Fox, for many years a member of the faculty of the College of Physicians and Surgeons, Columbia University, celebrated his ninetieth birthday on October 8. Dr. Fox was clinical professor of diseases of the skin from 1881 to 1904 and professor of dermatology from 1904 to 1907.

At a dinner to be held in London on November 24, a presentation from supporters of the British Science Guild will be made to Sir Richard Gregory, editor of *Nature*, who is chairman of the Council of Management, in recognition of his services to science generally and to the British Science Guild in particular. The president of the guild, the Right Hon. Lord Melchett, will preside.

Dr. Donald Dexter Van Slyke, of the Rockefeller Institute for Medical Research, has been awarded the Philip A. Conne Gold Medal of the Chemists Club, New York City, in recognition of his work in physiological chemistry.

At the recent meeting in London of the ninety-fifth session of the College of the Pharmaceutical Society of Great Britain the Hanbury Medal was presented to Dr. Frank Lee Tyman.

Nature states that the council of the British Illuminating Engineering Society has awarded the Gaster Memorial Premium to Ralph G. Hopkinson, for his paper on "The Photographic Representation of Street Lighting Installations," read before the joint meeting of the Illuminating Engineering Society and the Royal Photographic Society last December, and the Silver Jubilee Commemoration Award to W. R. Stevens, for his experimental work on "Thermal Endurance of Illuminating Glassware."

Professor Theodor von Kármán, director of the Daniel Guggenheim Graduate School of Aeronautics of the California Institute of Technology, has been appointed Rouse Ball lecturer at the University of Cambridge for the year 1936–37.

At the fifty-second annual meeting of the Indiana Academy of Science, held at Central Normal College, Danville, from November 5 to 7, under the presidency of Ray C. Friesner, of Butler University, officers elected for the ensuing year were: *President,* W. E. Edington, mathematics, DePauw University; *Vice-president,* C. A. Malott, geology, Indiana University; *Secretary,* L. A. Test, chemistry, Purdue University; *Treasurer,* W. P. Morgan, botany, Indiana Central College; *Editor,* Paul Weatherwax, botany, Indiana University; *Press Secretary,* M. W. Lyon, Jr., South Bend Clinic; *Academy Trustee,* John S. Wright, Eli Lilly Company. About 550 members were present. Ninety papers were presented before the nine sections of the academy. The address of the retiring president was entitled "Indiana as a Critical Botanical Area."

Dr. James Fisher has been appointed dean of the faculty of the Michigan College of Mining and Technology, Houghton. Dr. Fisher, who is head of the department of mathematics and physics, has been associated with the teaching staff of the college since 1896.

Dr. Donal Sheehan, of Victoria University, Manchester, will succeed Professor Emeritus H. D. Senior as professor of anatomy and director of the anatomical laboratories of the College of Medicine of New York University. The appointment will become effective on September 1, 1937.

Dr. John Homans, clinical professor of surgery in the Harvard Medical School and surgeon to the Peter Bent Brigham Hospital, has been appointed visiting professor of surgery in the Yale University School of Medicine and surgeon-in-chief of the New Haven Hospital, in place of Dr. Samuel C. Harvey, who has leave of absence from November 1 to June 30.

Dr. Frank R. Peterson, associate professor of surgery in the College of Medicine of the State University of Iowa, has been appointed professor and head of the department of surgery, succeeding the late Dr. Howard L. Beye.

John F. Wyckoff, formerly instructor in mathematics at South Dakota State College, and Dr. Thomas L. Downs, Jr., formerly instructor and tutor in mathematics at Harvard University, have been appointed instructors in mathematics at Trinity College, Hartford, Conn.

Dr. Arthur Haas, formerly professor of physics at the University of Vienna, the University of Leipzig and the University of London, is this year professor of theoretical physics at the University of Nôtre Dame. Dr. Haas made his first visit to America in 1927, at which time he lectured at leading universities. He was one of the guest speakers at the Harvard Tercentenary this past summer.

Oliver Shewell Franks, fellow of Queen's College, University of Oxford, has been appointed professor of moral philosophy to succeed the late Professor A. A. Bowman.

Dr. Hermann Burian, formerly assistant to the director of the eye clinic of the University of Bern, has been appointed visiting research fellow in the department of physiologic optics at the Medical School of Dartmouth College.

The Committee on Scientific Research of the American Medical Association has awarded grants to Dr. Warren O. Nelson, of Wayne University, to aid in the continuation of his studies on the effects of androgenic substances in the rat; to Dr. Wilbert H. McGaw, of the School of Medicine of Western Reserve University, to develop an auscultatory method of diagnosing and following the progress of bone fractures and other bone disorders; to Dr. William J. Turner, Chicago, for the study of porphyrins, porphyria and the urinary pigments of porphyria, and to Drs. H. P. Smith, E. D. Warner and K. M. Brinkhous, of the department of pathology at the State University of Iowa, for research on blood clotting.

Paul Marshall Rea, director of the Santa Barbara Museum of Natural History, has resigned, effective on December 31. He was granted leave that he may resume at once researches on which he was engaged when he took the post three years ago.

Dr. Richard S. Austin, professor of pathology in the College of Medicine of the University of Cincinnati, has been appointed a member of the Cincinnati Board of Health in the place of the late Dr. William B. Wherry.

Dr. Edward W. Wallace, pharmacologist of the Food and Drug Administration of the U. S. Department of Agriculture, resigned on November 1 to become pharmacologist at the National Institute of Health, Washington, D. C.

Julian M. Avery, electro-chemical and metallurgical engineer, formerly with the Union Carbide and Carbon Corporation, has joined the staff of Arthur D. Little, Inc., research chemists and engineers of Cambridge, Massachusetts.

Frank A. Patty, chemist in charge of the Gas Mask and Respirators Laboratory of the U. S. Bureau of Mines at Pittsburgh, Pa., has become chief chemist for the Fidelity and Casualty Company, of New York, where he will conduct investigations in industrial hygiene.

Professor John R. Bangs, Jr., of Cornell University, has been appointed chairman of the committee on the professional status and employment of engineering graduates of the Society for the Promotion of Engineering Education.

Dr. J. C. Th. Uphof, research botanist of Orlando, Fla., has returned from a four month botanical trip which he spent in the Balkan countries, especially in Bulgaria, Turkey and Jugoslavia. He was for a considerable time the guest of the Royal Biological Institute in Sofia, the private institution of King Boris III.

Sir Sydney Cockerell, director of the Fitzwilliam Museum, has been appointed as London adviser to the Felton Bequest for the next three years and left for Melbourne on November 7 to consult the trustees. The Felton Bequest to the National Art Gallery of Victoria is the largest single bequest fund in the empire for the purchase of art treasures, having an income of £26,000 (Australian) a year. Two years' income is now available for spending. Since it was established under the will of Alfred Felton, £493,750 has been spent upon works of art, books, furniture, glass and porcelain.

The first of three illustrated lectures sponsored by the Harvard Institute of Geographical Exploration was given on November 12, when Dr. Kirk Bryan, professor of physiography, spoke on "A New Theory of the Last Stages of the Ice Age in Southeastern New England." Bradford Washburn, explorer and assistant in geography, will give the second lecture on December 10, entitled "Over the Roof of the Continent," a lecture concerning his recent Alaska trip. The third lecture will be given on January 14 by Harmer Selvidge, assistant in physics, on "Eclipse Observations and the Kirghiz Borderland." It will give an account of the Harvard-Massachusetts Institute of Technology eclipse expedition to Russia last summer.

Sir Humphry Davy Rolleston, who was physician extraordinary to the late King George V, arrived in the United States on November 10. He addressed a group of surgeons and physicians in Washington on November 16 at a dinner celebrating the Army Medical Library Centennial. His subject concerned the debt the world owes to the oldest American medical library through its universal distribution of the cumulative *Index Medicus*. Before leaving for Washington Sir Humphry addressed the historical

seminar of the Yale Medical School. While in New Haven he was the guest of Dr. Harvey Cushing.

DR. RONALD A. FISHER, Galton professor of eugenics at University College, London, delivered two lectures at Yale University on October 27. The first was before the Neurological Study Unit of the Yale University School of Medicine on "Purpose of Design in Experimentation." The second was a Woodward lecture entitled "The Rôle of Genetical Mutations in Evolution." Dr. Fisher lectured at the University of Minnesota on October 19 and a few days earlier at the University of California.

DR. D'ARCY WENTWORTH THOMPSON, professor of natural history at the University of St. Andrews, Scotland, president of the Royal Society of Edinburgh, is giving a series of six Lowell lectures in Boston on "Growth and Form in Plants."

DR. FLORENCE DE L. LOWTHER, professor of zoology at Barnard College, was the guest of honor at the Barnard College Club on November 5. Dr. Lowther, who recently returned from the Belgian Congo, described her experiences and showed motion pictures taken on the trip.

DR. LINUS PAULING, professor of chemistry at the California Institute of Technology, on November 4 addressed the University of California at Los Angeles Chapter of the Society of the Sigma Xi on "The Use of Magnetic Methods in Chemistry."

THE two hundred and ninth regular meeting of the American Physical Society will be held in Chicago on Friday and Saturday, November 27 and 28. On Friday evening, November 27, there will be a joint dinner with the Chicago Physics Club held at the International House, on the university campus. At this dinner Dr. K. K. Darrow, of the Bell Telephone Laboratories of New York, will speak on "Spinning Atoms and Spinning Electrons."

A WIRELESS dispatch to *The New York Times*, dated November 14, reports that Dr. Willi Menzel, professor of armament technique in the Berlin Technical Institute at Charlottenburg, has been appointed director of the German Central Association for Scientific Research, to succeed Dr. Johannes Stark, formerly professor at Würzburg. Dr. Menzel has been for two years head of the research department of the National Socialist Ministry of Education. The association controls the funds available for research work in Germany. Dr. Menzel is said to have published recently an article attacking theoretical physics as developed by Dr. Einstein and other distinguished Jewish men of science.

DISCUSSION

ANOTHER NOTE ON SCIENTIFIC WRITING

MR. URBACH deplores the prevalent low standard of scientific exposition.[1] He complains about (a) verbosity, (b) the circumlocutory passive and (c) mixed figures of speech. His examples convince him and me, but they may not convince their authors and the majority of the publishers of research. And, if there is a difference of opinion, who is right? Doubtless he has found that many persons will not accept his editorial dicta and that he often has to validate against dissent his claim that one form is better than another. So what determines *good* and *bad*? Usage? Hardly. It is scientific usage which Mr. Urbach seeks to improve. Plainly we need to find a principle of validation.

We can not have rules. All cases are debatable, and there is no dictator to hand down decisions. What we need is a clear recognition of the purpose of scientific writing, and then perhaps we may hope for agreement on the principle that the best writing is the writing that most nearly fulfils its purpose. The purpose of scientific exposition, surely, is publication, and what is in the writer's mind becomes public only when many other persons read and understand him. Research, we are told often enough, is not complete until it is published, but we need also to be reminded that the badly written report may find no public because it is too forbidding to be read. Thus it would not be truly published at all. The writer needs to have his public in mind as he writes.

To have his public in mind, to be writing to a definite audience, is a specific mental attitude on the part of the writer, an attitude which, if developed with skill, solves—and here lies my thesis—all the problems which Mr. Urbach raises. There seems to be no good word for this attitude. *Benevolence* and *altruism* are much too pompous, though etymologically exactly right. The absence of *egoism,* the opposite of what the Freudians call *narcissism,* is what I have in mind. The successful expositor thinks about his audience and forgets himself in his eagerness to guide the growth of thought in their minds. That is the goal whose approximation would prevent Mr. Urbach and me from writing notes about scientific writing, and yet how often the researcher thinks he has accomplished his purpose when he puts an idea behind a barrier of confusing verbiage.

[1] W. F. Urbach, SCIENCE, 84: 390–391, October 30, 1936.

Let us apply this "contra-narcissistic" principle to the standard cases and see what happens.

(1) First there are the mixed figures. In them we have a problem of usage and of the prevalence of visual imagery. The novel figure should arrest attention and render the idea vivid. If the figure is mixed, then the alert visualizing reader will at once see an incongruity, and his attention will be diverted by puzzlement or amusement. That is what is the matter with *the ultimate consumers for the body of biological knowledge* (Mr. Urbach's instance): the visual image is either humorous or offensive and in either case it is not illuminating. The reader who is not visually minded may, however, take this phrase as graceful since it is enriched by extrinsic allusion. The answer to the question as to whether the phrase is bad lies not in any absolute dictum about mixing, but in the relative proportions of help and hindrance that it introduces into the comprehension of an idea by the intended audience.

A good figure gets repeated. First it becomes a cliché. Ultimately it becomes a new meaning for a word, and the meaning is put into a dictionary. With repetition the visual imagery tends to drop off. Only the alert stylist objects to the cliché, and no one objects to new meanings after usage has justified them. We write: *This stimulus is far below the threshold.* I defy any one to visualize that figure and get thereby the intended meaning. Vertical doorways have thresholds; trap doors do not. The prepositions for threshold should be *outside* and *inside,* or *before* and *beyond,* but it is easy to see how usage has justified this mixed figure that will not be visualized. Low values of the stimulus are *sub*liminal, and the depths of the unconscious are far below the threshold of consciousness. A figure that is bad when visualized becomes good when usage strips it of its visual context. The author must estimate his audience in respect of visualization and familiarity and write accordingly, if he is to achieve maximal *publication*.

(2) What is the author to do when he is describing events of which he himself is the agent? Is he to say *I, we, the writer, one,* or does he drop into the circumlocutory passive? No grammatical rule can be adequate to this problem. The admonition to write so skilfully that the problem does not arise is lost on the untrained writer. Yet there is one rule that works very often; it is this "contra-narcissistic" principle. If the author will get his attention off himself and on his readers, if he will forget his own personal activities and begin to talk about facts as a function of method, he will find that half of these difficulties never arise. It is his own preoccupation with himself and the difficulties of his research that make him so personal. Sometimes it is his fear that his results will not stand generalization that makes him limit himself to the minutiae of the particular—the truth as it stood for him on Wednesday afternoon, the 18th. I do not mean that he should obscure the particular in his generalizing, but only that he should be thinking about the generalization because it is all that most of his readers wish to get from him.

In the other half of the cases the author must ask himself: What would my readers prefer? It is simplest to say *I* for the author, *we* for joint authors, and *we* for the single author and his reader having a communal idea. *We* for the single author offends many persons, because there is no visual image for it short of majesty. The *New Yorker* uses this *we* to achieve humor: "we ourself." The passive irritates the reader who wants clear direct diction. So also does the too frequent use of *I*. It is entirely a problem as to when *I* is egoistic! It is plain that the reader expects more deference and fewer *I*'s from the young author than from an older, well-known writer, but my own judgment is that even the young writer may safely use *I* if he really feels a deference for his reader. And why should he not, since the existence of his public is a necessary reason for his research? The altruistic principle here reduces to a matter of good manners. The first person singular will not offend if it is used modestly.

(3) No argument is needed about verbosity and circumlocution. They are bad because they effect the author's purpose poorly. The reader's comprehension is convenienced by the direct terse statement, and the reader's comprehension is the author's only purpose.

(4) What about the adjectival noun that is common in scientific writing? Is it bad? May one say *maze learning* without a hyphen, or *dementia praecox patient?* And, when these patients learn mazes for experimental purposes, is it all right to say *dementia praecox patient maze learning?* And, if not, where is the threshold *beyond* which safety lies? It is mostly a question of what offends the reader's taste, and his taste is arbitrary and irrational. English is not German, but probably most scientists accept a single adjectival noun without interruption of the flow of thought, and certainly many accept two adjectival nouns connected by a hyphen. Clarity suffers when there are too many because it is then not clear what modifies what. The author must guess how his style will be related to the readers' comprehension and taste. In general, however, he offends less against clarity or taste when he avoids the adjectival noun than when he uses it.

(5) And are not apologies generally out of place? The writer is not serving the reader in defending himself. Writing is not like talking. If a man writes

that for which he must apologize, he can unwrite it before he goes to press. Surely no reader really wants to read apologies.

My conclusion is that good writing is a form of good manners. Like good manners it has to be learned, and there are individual differences in aptitude for it. It is best learned in youth, and the way to start is for the writer to shift his attention away from himself and to focus it upon that audience whose comprehension of his thought is his only reason for writing at all.

EDWIN G. BORING

HARVARD UNIVERSITY

THE APPROXIMATE CONNECTION OF BOILING POINTS FOR VARIATION IN BAROMETRIC PRESSURE

IT is well known[1] and may be readily demonstrated that, for normal liquids, changes in the boiling point, corresponding to small changes in the pressure, may be represented by the following equation:

$$\triangle T = \frac{RT_B}{21} \times \frac{\triangle P}{P}$$

where T_B is the boiling point (in degrees absolute) at the pressure P, R is the gas constant (in calories per mol), and $\triangle P$ and $\triangle T$ are the corresponding changes in pressure and temperature. However, it does not appear to be common knowledge that the relation may be stated in the following readily remembered form.

$$\triangle T = \frac{T_B}{10} \triangle P_{atm.}$$

That is, that the change in the boiling point is equal to one tenth of the product of the normal boiling point (in degrees absolute) and the change in pressure, expressed in atmospheres.

When applied to changes of 15 or 20 mm this rule gives results, for normal liquids, which do not differ from the correct values by more than 0.1° C. Although it overcorrects the boiling points of highly associated liquids, the error introduced by applying it to even such abnormal liquids as water or methyl alcohol is less than half of the original correction.

ROBERT LIVINGSTON

UNIVERSITY OF MINNESOTA

OPINIONS RENDERED BY THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE[1]

SUMMARIES of the Opinions are as follows:

Opinion 124.—The various Subdivisions of genera published by Linnaeus in 1758 are not to be accepted as of this date (1758) as of subgeneric value under the International Rules.

Opinion 125.—*Borus* Agassiz, 1846, is an emendation of, and therefore an absolute synonym of, *Boros* Herbst, 1797; *Borus* Albers, 1850, is a dead homonym.

Opinion 126.—On basis of evidence and expert advice of outstanding specialists, the commission does not see its way clear to declare the new names in d'Orbigny's, 1850, "Prodrome" as unavailable or as *nomina nuda* under the Rules.

Opinion 127.—Complying with expert advice from specialists in the group involved, the commission herewith suspends the Rules and places *Lepidocyclina* Gümbel, 1868, type *Nummulites mantelli,* in the Official List of Generic Names, with *Cyclosiphon* Ehrenberg, 1856, type *Nummulites mantelli,* as objective synonym. The consultants agree, almost unanimously, that to apply the Rules in this case would produce greater confusion than uniformity.

Opinion 128.—Under suspension of the Rules *Nycteribia* Latreille, 1796, with *pedicularia* Latreille, 1805, as type, and *Spinturnix* von Heyden, 1826, with *myoti* Kolenati, 1856, as type, are hereby placed in the Official List of Generic Names.

The specific name *vespertilionis* of all authors is hereby invalidated for the following generic names: *Acarus, Acrocholidia, Celeripes, Dermanyssus, Diplostaspis, Gamasus, Hippobosca, Ichoronyssus, Liponyssus, Listropoda, Megistopoda, Nycteribia, Pediculus, Penicillidia, Periglischrus, Phthiridium, Pteroptus, Sarcoptes, Spinturnix, Strebla,* on the ground that the application of the Rules would produce greater confusion than uniformity.

Opinion 129.—The rules are herewith suspended in the case of *Bipinnaria* 1835 vs. *Luidia* 1839, on the ground that "the strict application of the Règles will clearly result in greater confusion than uniformity." *Luidia* Forbes, 1839, with monotype *fragilissima* 1839 (subjective synonym of *Luidia ciliaris* 1837), is hereby placed in the Official List of Generic Names. The names *Auricularia, Bipinnaria, Brachiolaria,* and *Pluteus* are hereby excluded from availability as generic names and are reserved as designations of developmental stages.

Opinion 130.—Under suspension of the Rules *Lytoceras* Suess, 1865 (genotype, *Ammonites fimbriatus* Sowerby) is hereby placed in the Official List of Generic Names.

Opinion 131.—The type species of *Tromikosoma* is *T. koehleri.*

Opinion 132.—The "Gattungsbezeichnungen" published by Sobolew, 1914, are of the same nature as the designations published by Herrera; namely, formulae, not generic names, and have no status in Nomenclature. See Opinion 72.

[1] See, for example, MacDougall, "Thermodynamics and Chemistry," Wiley, 1926, p. 133, New York.

[1] Opinions 124 to 133. Smithsonian Miscellaneous Collections, vol. 73, no. 8, October 28, 1936. (Publication 3395).

Opinion 133.—Under the Rules, the type of *Urothoe* is *U. rostratus.* The original author of a family name is free to select any contained genus as the nomenclatorial type of that family. It is not necessary to select the oldest included genus as type genus for the family. Under the present premises it is unnecessary to substitute the newer name Urothoidae 1932 for the earlier Phoxocephalidae.

C. W. STILES

WASHINGTON, D. C.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MEETING OF THE EXECUTIVE COMMITTEE

THE fall meeting of the Executive Committee was held at Atlantic City on October 24 and 25, 1936. The following members were present: Drs. Cattell (*chairman*), Caldwell, Chamberlin, Conklin, Livingston, McKinley, Ward, Wilson and Woods. In addition to the usual number of formal business items and minor matters, the following deserve record here:

The constitution of the American Association for the Advancement of Science provides in the complete plan of the association for a Section on Manufactures and Commerce. The advisability of organizing this section to provide for active and careful scientific discussion of questions of outstanding importance has been brought up many times and came up for discussion as a question of association policy. The Executive Committee requested Dr. Wilson to bring together a group to consider the feasibility of such a move, and if discussions warrant, authorized him with the full approval of the Executive Committee to take steps towards formulating a plan to be presented to the council at the Atlantic City meeting.

The rôle of affiliated state academies was discussed in connection with a communication suggesting the organization of a state association for the advancement of science for coordinating the activities of scientists within the state. No action was taken, but the opinion was expressed that such a function fell clearly within the powers of a state academy.

The program for the Atlantic City meeting was carefully discussed and plans made to provide on Friday a general luncheon for all sections and societies. It is expected that a distinguished member of the British Association will be present to deliver an address after the luncheon. Discussion of the Atlantic City meeting brought out the fact that sessions of many sections and societies would close on Thursday evening or earlier, and that this fact would imperil the success of the sessions planned for Philadelphia on the following Saturday. Other special features are being provided for Friday, and a detailed announcement will be made shortly. The association will adjourn on Friday evening to meet at Philadelphia on Saturday, January 2. Members attending will be guests of the various scientific organizations in Philadelphia and special courtesies arranged for that occasion. Full details will be published soon.

In view of the pressure at meetings, which has been the subject of frequent comment, the Executive Committee felt that the situation could be greatly improved to the advantage of all concerned by extending the number of days utilized for sessions. This would provide more time for the discussions of papers and for additional joint sessions. Plans were discussed for presenting the advantages of the change suggested to the various affiliated societies.

The dates of the Richmond meeting were changed to provide that the meeting open formally on December 27, 1938.

The financial reports of the treasurer for the fiscal year 1936 were presented, accepted and ordered audited. The treasurer's budget for the fiscal year 1937 was referred to the council for approval with such adjustments as may be desired.

The financial reports of the permanent secretary for the fiscal year 1936 were presented, accepted and ordered audited. The permanent secretary's budget for the fiscal year 1937 was referred to the council. The financial report of the Saint Louis exhibition and the budget for the Atlantic City exhibition were approved as presented.

The general secretary reported verbally plans for the academy and secretaries conferences, status of branches and junior academies, and plans for establishing other branches.

Dr. Woods reported that the Occasional Publication (No. 3) containing the symposium papers on "The Scientific Aspects of Flood Control," read at the Rochester meeting, had been published.

The permanent secretary was advised to have copies made of a report submitted by Dr. Miles with regard to procedure for awarding the annual Association Prize. It was felt that these copies should be distributed to secretaries of sections and affiliated societies in order to develop a better understanding of the situation and of the methods of securing maximum advantage in connection with this award.

On recommendation of the respective sections, fellows were elected as follows: Psychology, 5; Engineering, 1; Medical Sciences, 1.

The American Psychiatric Association was accepted as an affiliated society. (This organization has a total membership of 1,912. Of this number 135 are members of the association, 73 of these being fellows. The organization is entitled to one representative in the council of the association, who will be *ex-officio* a member of the section committee of the Section on Medical Sciences.)

The Florida Academy of Science was accepted as an affiliated state academy, with one representative in the council of the association.

The Alpha Epsilon Delta Pre-Medical Fraternity was accepted as an associated society. (This organization has a total membership of 985 members. Of this number, 47 are members of the association, 37 of these being fellows.)

Dr. Conklin was appointed the representative of the association at the Centennial celebration of Emory University in December, 1936.

The permanent secretary and the general secretary were appointed representatives to the First National Conference on Educational Broadcasting, to be held in Washington, from December 10 to 12, 1936.

Dr. Caldwell was appointed the association's representative to the Tokyo Conference of the World Federation of Education Associations, and he was asked to confer with Dr. Paul Monroe on the possibility of the association's cooperation in organizing the program of the section on science for this congress.

Certain matters were reported for record:

President Conklin served as delegate at the meeting of the British Association at Blackpool, from September 9 to 16, 1936.

For the International Conference on Letter Symbols for Heat and Thermodynamics, held at the headquarters of the American Society of Mechanical Engineers, New York City, from September 14 to 15, Dean George B. Pegram, Columbia University, and Professor George F. Bateman, Department of Mechanical Engineering, Cooper Union, were selected as representatives and served in that capacity.

For the Centennial Celebration of the Chartering of Wesleyan College, Macon, Ga., on Friday, October 23, Dr. A. S. Edwards, head of the Department of Psychology at the University of Georgia, was appointed and served as delegate.

The meeting adjourned at 3:30 P. M. to meet in Atlantic City on December 27.

Henry B. Ward,
Permanent Secretary

SPECIAL ARTICLES

VITAMIN C IN PASTEURIZED MILK

Our results and those of Whitnah and Riddell[1] indicate that the vitamin C or ascorbic acid content of fresh milk is relatively constant throughout the year, although variations occur in individual cows. No increase in the ascorbic acid content of cow's milk was produced by green feeding nor of goat's milk by intrajugular injection of 4 grams of ascorbic acid daily.

Plant tissues which contain ascorbic acid apparently also contain an ascorbic acid oxidizing enzyme which is liberated when the cells are crushed. The enzyme in some plants is very active. For example, the large amount of ascorbic acid present in cabbage is completely oxidized within 5 minutes after the previously frozen raw cabbage cells are disintegrated. While the feed is masticated and stored in the rumen by the cow, all the ascorbic acid it contains is probably oxidized. Therefore the cow and animals with similar digestive systems, and possibly birds, must either synthesize ascorbic acid or reverse the oxidation.

Variations in the rate of oxidation of ascorbic acid in milk can be explained best by assuming the presence of an ascorbic acid oxidase, the action of which is markedly accelerated by traces of dissolved copper.

[1] Science, 83: 162, 1936.

The milk from individual cows varies in ascorbic oxidase activity. Our experiments indicate, although the proof is not yet conclusive, that ascorbic acid disappears more rapidly from winter milk (dry feed) than it does from summer milk (pasture feed). This may be due to a difference in amount of enzyme or of copper. Some investigators report that the vitamin C feeding value of summer milk is higher than that of winter milk. Failure to feed immediately after milking, or immediately after pasteurizing, accounts for some of the conflicting conclusions which appear in the literature.

A very slight destruction of the enzyme occurs in milk pasteurization by the "holder" method (30 minutes at 62–63° C., 143–145° F.). This method gives satisfactory bacterial destruction without injuring creaming ability. Heating for one-half minute or longer at 77° C. (170° F.) destroys the enzyme and so retards the oxidation of the ascorbic acid, but it also destroys the creaming ability which is demanded by consumers. Less severe heating exerts some preserving effect, depending on the partial destruction of the enzyme.

Traces of dissolved copper in milk heated to 77° C. or higher have very little accelerative effect on the oxidation of ascorbic acid when compared with the

accelerative effect produced in raw or holder pasteurized milk, because heating to 77° C. destroys the enzyme.

It has been stated repeatedly that raw milk contains more vitamin C than holder pasteurized milk. The difference has been erroneously attributed to oxidation caused by the heating. Milk heated in glass for one hour at 63° C. actually contains more ascorbic acid after holding cold for 3 days than does an aliquot held raw for the same time. This is because more of the enzyme than of the ascorbic acid is destroyed by 1 hour's heating. An insignificant amount of ascorbic acid is destroyed by heating in glass for 30 minutes at 63° C. and the enzyme is weakened slightly.

This leads to the very important conclusion that milk heated under the conditions of time and temperature specified for holder pasteurization may for all practical purposes be as potent in vitamin C as raw milk. The interrelations between the effects of enzyme, copper and pasteurization were studied on 355 aliquoted samples. The values below are the averages expressed in mgms of ascorbic acid per liter of milk:

Fresh milk	20.1
Held 3 days at 2° C.	
Raw	11.3
Past. (30 min. 62–63° C.)	11.0
Past. (30 min. 62–63° C.) + .13 p.p.m. Cu	1.7
Past. (10 min. 77° C.)	15.7
Past. (10 min. 77° C.) + .13 p.p.m. Cu	12.4

If appreciable destruction of ascorbic acid occurs during commercial pasteurization it is caused by copper contamination from the equipment. However, even with copper contamination most of the destruction in commercial bottled milk occurs in the cold milk during holding after pasteurization, and not during pasteurization.

While every contingency of the commercial application of these results has not been investigated, yet experiments up to this time indicate that if milk has not been contaminated with copper, pasteurization by the holder method in glass, aluminum or chromium steel containers will not accelerate appreciably the rate of destruction of ascorbic acid. It is not sufficient to have only the main parts of the equipment of the approved materials; parts of the equipment which are often overlooked, such as thermometer couplings, valves, pumps, unions, pipes and bottling equipment must be free from copper and its alloys. Completely tinned copper, while satisfactory when new, soon wears through and therefore is a common source of copper contamination.

Dr. E. S. Guthrie took daily samples at various stages during the passage of milk through a small commercial market milk plant. Milk which when fresh contained about 20 mgms of ascorbic acid per liter, after holder pasteurization in a chromium steel vat and holding for 3 days at 2° C. contained 11.0 mgms (raw milk about 11.3); after passage over a well-tinned, external, tubular cooler (through aeration and exposure to oxygen absorption) the amount was about the same; and after bottling, 5.5 mgms. The milk came in contact with small areas of exposed copper and copper alloy in the bottler.

The ascorbic acid content of samples of commercial bottled milk, obtained from various distributors in different cities, was determined when the milk was about 3 days old. The average of 457 samples of pasteurized milk was 2.2 mgms, and of 63 samples of raw milk 7.9 mgms of ascorbic acid per liter. Many of the raw milk samples contained no ascorbic acid, which was to be expected, since much of the raw milk sold comes in contact with copper. The addition of 0.13 mgm of copper per liter to milk pasteurized in glass (62–63° C. for 30 minutes) reduced the ascorbic acid to 1.7 mgms per liter at the end of 3 days at 2° C. This amount of copper corresponds roughly to the amount which much of the milk acquires as it is now handled commercially.

Reports in the literature indicate that ascorbic acid is the only substance present in milk which is oxidized with 2–6 dichlorphenolindophenol and that the biological test for ascorbic acid is in general agreement with the amount determined by titration. The values for ascorbic acid reported here are all based on the results obtained by titrating, with 2–6 dichlorphenolindophenol, 10.0 ml of milk which was acidified with 25 ml of 0.1 N sulfuric acid. Direct titration of the milk eliminates the error due to the destruction of ascorbic acid which occurs during the filtration involved in older methods, and apparently the proteins do not interfere. By using 4 burettes and titrating 4 samples simultaneously, to an end point which is permanent for 30 seconds or more, 40 or more determinations can be made in an hour. An approximation of the amount of copper in milk can be obtained by heating for 10 minutes at 77° C., cooling, adding a definite amount of ascorbic acid, and determining its rate of disappearance.

This investigation indicates that it is commercially feasible to pasteurize milk by the holder method and maintain essentially as high an ascorbic acid content as that of raw milk at the same age. This removes the main nutritional objection to pasteurized milk. Furthermore, it is possible by using higher temperatures to produce pasteurized milk which when held will exceed in ascorbic acid potency raw milk of the same age.

PAUL F. SHARP

CORNELL UNIVERSITY

RESTLESSNESS AND MORBID HUNGER IN MAN[1]

THIS study began with the observation in children who had epilepsy and other signs of lesions of the brain, of a symptom-complex consisting of marked restlessness, mental deficiency and, in some cases, morbid hunger. These cases presented similarities to experimental animals which, following removal of the prefrontal region of the brain, show excessive motor activity, morbid hunger and mental defects.[2] A study was then made of a series of 279 restless children to determine whether there was evidence in them to indicate a lesion of the prefrontal cortex.

The cases were divided into three groups: (1) markedly restless children; (2) mildly restless ones; (3) children who were restless at home but not on their visits to the clinic. An analysis of the intellectual performance on the Binet-Simon scale showed that the average intelligence quotient of the first group was 62; of the second, 86; and of the third, 95. A control group of 273 non-restless cases averaged 92 in intellectual status. Evidence of organic brain disease, including developmental defect, was present with much greater frequency in the markedly restless group (98 per cent.) than in the least restless group (43 per cent.). Morbid hunger occurred in 44 of the cases and was similarly associated with mental defect and with frequency of cerebral lesions. The close association with mental deficiency suggests that the brain defect involves predominantly the prefrontal region.[3]

Milder degrees of restlessness, particularly when readily controllable, are seen in otherwise normal children and do not indicate organic disease of the brain.

Marked restlessness, morbid hunger and mental deficiency thus constitute a syndrome in man, analogous to that observed in experimental animals. It appears to be due to a lesion of the prefrontal region of the brain. The syndrome occurs in a variety of disorders at all ages of life, but particularly in developmental anomalies and senile degenerations.

PAUL M. LEVIN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

DETERMINATION OF THE VISUAL POWER OF EACH EYE IN ANIMALS[1]

IN attempting to delineate the exact loss of visual power after unilateral occipital lobectomy in monkeys, it was desired to test the ability of the homolateral and contralateral eyes individually. Covering one eye with bandages was unsuccessful in monkeys, first, because they tore the bandage away, and second, because it interfered with attention in visual discrimination tests.

The idea then presented itself that an opaque plaque made to fit in the conjunctival sac might solve the problem. After trying a number of plastic substances success was attained with paraffin. Its translucence was overcome by suspending in it finely divided charcoal. The plaques are hand-made just before use, and inserted while the animal is under cyclopropane anesthesia.

Within one hour of insertion the animal exhibits no consciousness of the presence of the plaque, and will go through tests as well as normally. Over periods up to 48 hours no damage has resulted beyond a slight conjunctivitis, which rapidly subsides.

GEORGE L. MAISON

PERMANENT PRESERVATION OF SMALL ZOOLOGICAL SPECIMENS

DR. E. O. ESSIG'S[1] recent account of reconditioning some small insects brings to notice the fate which befalls much valuable zoological material. The success of his efforts, resulting from astute deduction of obscure data, and the employment of a skilled technique can not always be duplicated, because of the nature of the material. In many instances, type specimens and valuable dissections are irretrievably lost, because of their original preservation in small vials. It seems impossible to devise any kind of removable stopper for these containers which will prevent the evaporation of the fluid preservative, sooner or later. Some workers enclose their vials in a larger container, and keep the latter filled with fluid, but this does not insure against carelessness of some future custodian.

For fifteen years soft parts of mollusca have been preserved at the California Academy of Sciences by hermetically sealing them in glass tubes. The method was devised because of the personal loss of a collection of dissections during a long absence from the country.

A person does not need to be an expert glass blower to make the seal. The usual laboratory blast lamp is the only equipment needed. Ordinary soft glass test-tubes make excellent containers. Since the work-

[1] From the sub-department of neurology, The Johns Hopkins University.

[2] L. Bianchi, "The Mechanism of the Brain and the Function of the Frontal Lobes," Wm. Wood and Company, 1922; J. F. Fulton, C. F. Jacobsen and M. A. Kennard, *Brain*, 55: 524, 1932; C. P. Richter and M. Hines, paper read at the Second International Neurological Congress, 1935.

[3] A. F. Tredgold, "Mental Deficiency (Amentia)," Wm. Wood and Company, 1929.

[1] From the Department of Physiology, University of Wisconsin.

[1] E. O. Essig, SCIENCE, n. s., 84: 2167, 47–48, July 10, 1936.

ing of these in the burner is not difficult when the size does not exceed about 25 mm in diameter, much valuable small material can thus be preserved. Larger specimens are not so apt to be allowed to dry up in jars.

The specimen with all necessary labels is placed in the bottom of the tube, and a pointed flame is applied sufficiently far above the paper that it will not scorch. As soon as the glass softens all around, it is slowly drawn down to a narrow neck (*b*, Fig. 1). After

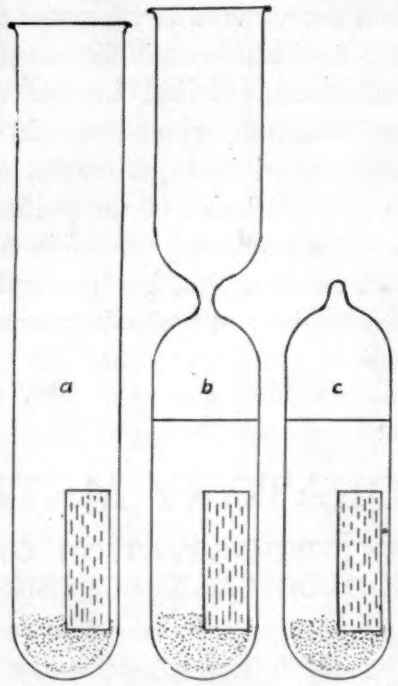

FIG. 1. Steps in the process of hermetically sealing zoological specimens: *a*. Specimens and label in tube. *b*. Tube reduced to a narrow neck and fluid added. *c*. The seal completed.

cooling for a few minutes, the preservative should be added. Just a touch of the flame will then seal off the constriction (*c*, Fig. 1).

There is no difficulty in flattening the bottom of the test-tube, if this be desired. Merely heat the bottom to the softening point, and press down on a piece of warm asbestos board.

There may be an objection that specimens so preserved are not accessible, but in practice it is found that the seals are so quickly and easily made, there is no hesitation in breaking a container when need arises.

G. D. HANNA
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LABELING MUSEUM SPECIMENS AND LABORATORY EQUIPMENT

AN article by E. E. Jacobs and Mary Auten published under the above title in No. 2174 of SCIENCE inspires me to tell the readers of SCIENCE about another method of labeling museum specimens, one used successfully by me for a great many years. In my opinion our method is, in some respects, more convenient than that devised at Ashland College.

We label with enamel paints, using white enamel for the labels and black for the numbers. The surface, whether a fossil or a glass bottle, does not need any preparation. However, it is necessary to observe that the labeled surface be neither dusty nor greasy—precautions always observed in painting. With a small camel's hair brush we first make white labels in dimensions corresponding to the size of the labeled specimen. The enamel should be applied rather sparingly, just enough to cover and level the original surface and to give a uniform, shiny, smooth surface. The labels are dry enough in a few hours, but we prefer to let them stand over night, numbering them the next day. The numbering is done also with a camel's hair brush of the smallest available size, carefully selected as to its point. A skilful operator can write a legible and good-looking number of four figures on a label a quarter of an inch long. In the same way as numbered labels we put on specimens all other kinds of marks, for example, small round disks of green to mark the types. Varied color combinations combined with different shapes of labels permit the expression of a wide range of meanings. When, for any reason, it becomes necessary to remove the labels or to change a number, they may be scratched off with a knife from a smooth surface such as glass, or in other cases it can be done with paint remover and turpentine. The amount of enamel used for such work is very small and a half pint can will last for months, provided that the enamel be protected against drying out. We never use enamel directly from the can but pour a small amount of it, say a teaspoonful, into a small, wide-necked bottle with a ground glass cap. Another bottle of the same kind but a little larger is used for turpentine. Two bottles and a brush make the complete equipment for every color used in labeling, numbering and marking.

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BOOKS RECEIVED

APPEL, KENNETH E. and EDWARD A. STRECKER. *Practical Examination of Personality and Behavior Disorders—Adults and Children*. Pp. xiv + 219. Macmillan. $2.00.

DAVIS, HAROLD T. *The Theory of Linear Operators*. Pp. xiv + 628. 15 figures. Principia Press. $8.00.

HAHN, OTTO. *Applied Radiochemistry*. Pp. xi + 278. 69 figures. Cornell University Press. $2.50.

HOBBS, WILLIAM H. *Peary*. Pp. xv + 502. Illustrated. Macmillan. $5.00.

MACELWANE, J. B. and F. W. SOHON. *Introduction to Theoretical Seismology. Part I, Geodynamics*. Pp. x + 366. 67 figures. Wiley. $6.00.

PARKINS, A. E. and J. R. WHITAKER, Editors. *Our Natural Resources and Their Conservation*. Pp. xii + 650. Illustrated. Wiley. $5.00.

Smithsonian Institution. *Annual Report, 1935*. Pp. xiv + 580. Illustrated. U. S. Government Printing Office. $1.00.